Targeted Mineral Carbonation to Enhance Wellbore Integrity

Award Number: DE-FE0026582

Project Summary:

This project evaluated the potential to deploy targeted carbonation reactions to the leading edge of leaking carbon dioxide (CO_2) as a strategy for mitigating leakage from deep CO_2 injection sites. This project focused on the development of temperature-responsive coated mineral silicates that can be used in the targeted treatment and remediation of leaking CO_2 in geologic storage sites and wellbores. This self-targeted approach eliminates the need for leaks to be precisely located before they can be mitigated, thus improving confidence in containment. Specifically, this project synthesized coated mineral silicates and evaluated their ability to mitigate leakage experimentally and with forward modeling.

Prime Performer:
University of Virginia

Key Performers:
Princeton University

Principal Investigator:
Andres Clarens

Project Duration:
10/1/2015 – 6/30/2019

Performer Location:
Charlottesville, Virginia

Program:
Carbon Transport & Storage

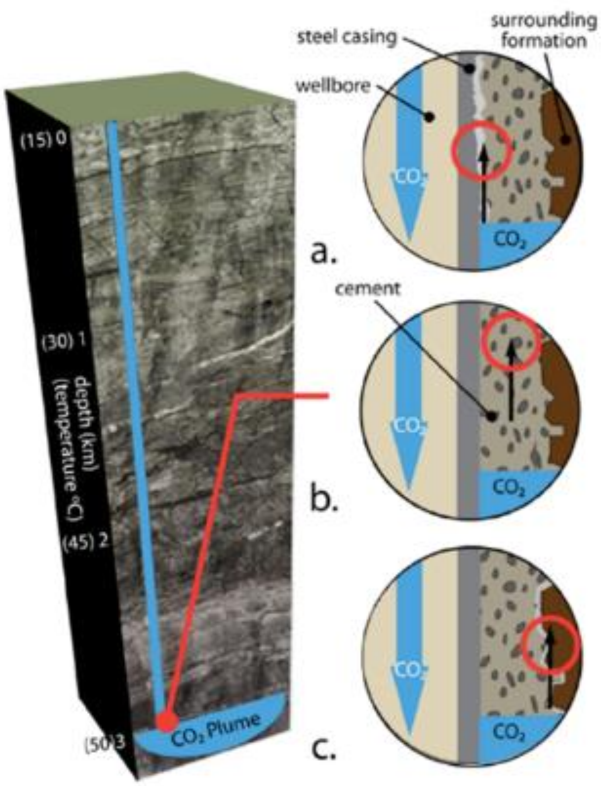

Figure 1: Schematic cross section of a plugged wellbore illustrating potential leakage pathways through: a) casing and cement; b) the cement pore space as a result of cement degradation; and c) cement and rock.

Project Outcomes:

In this work, laboratory experiments and model simulations were performed to address key early-stage research questions that determine the feasibility of this leakage mitigation strategy. Experiments showed that injected mineral silicates are effective in reducing permeability in porous media and polymer coatings and may be utilized to effectively facilitate particle transport to lower temperature regions where leakage events are taking place. Additionally, batch experiments found that the crystalline silicate precipitates are more stable than calcium carbonate at low pH conditions, which would be very valuable for creating permanent seals in subsurface applications.

Particle injection processes modeling considered the engineering design and delivery of mineral silicate particles that would maximize efficiency. A 2D modeling domain was defined and particle transport into an idealized formation was estimated. The results suggest that particle design, injection conditions, and target formation geology impact particle penetration into the formation. The size and surface properties of the particles have the greatest effect on transport distance, followed closely by the grain size of the porous medium.

Presentations, Papers, and Publications

Final Report: Targeted Mineral Carbonation to Enhance Wellbore Integrity (September 2019) – Andres Clarens, Catherine A. Peters, Jeffrey P. Fitts